



# The Neutron Optics Test Station NOTS: Instrument performance estimated by Monte Carlo simulations

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# General consideration

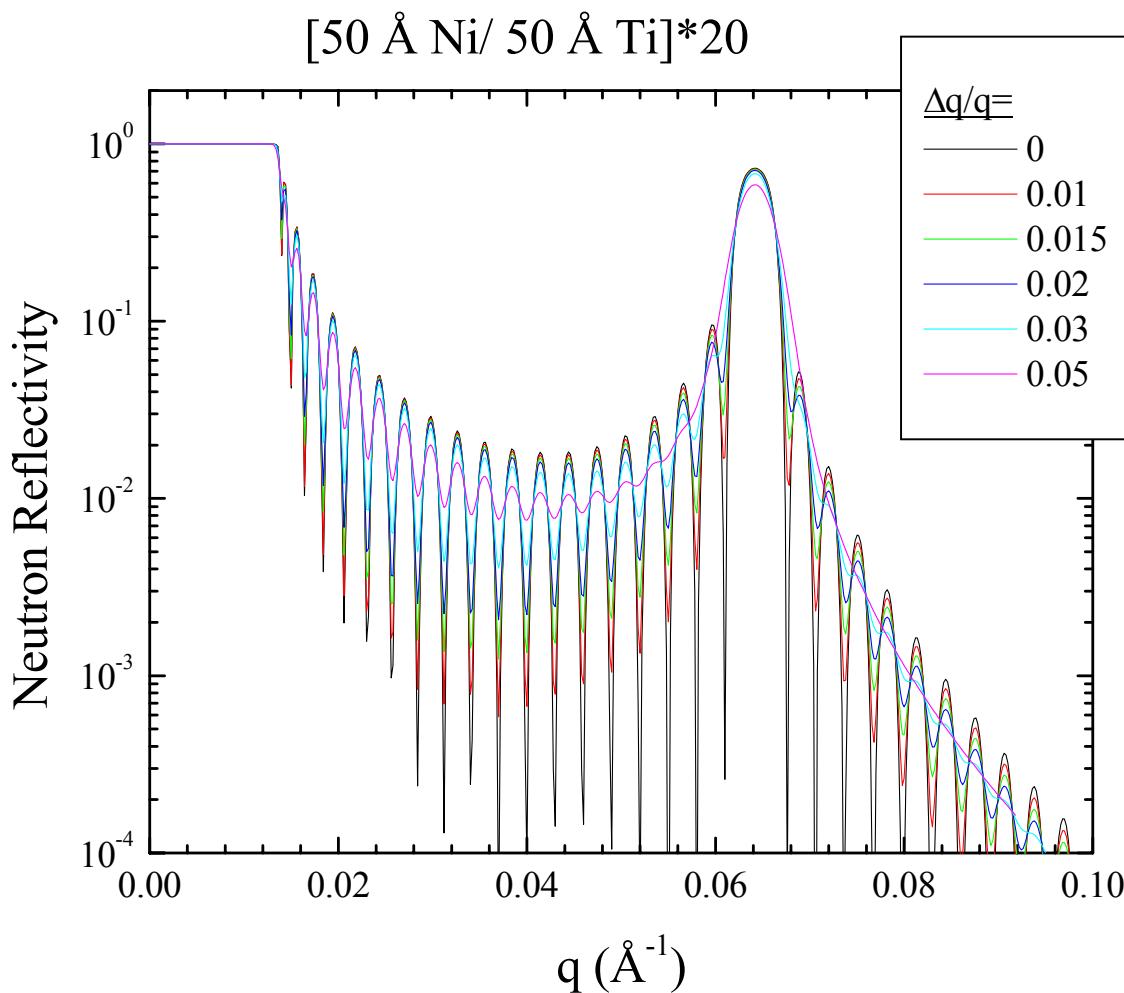


Wide-bandwidth neutron optical devices/components to be studied at NOTS include

- Supermirrors
- Neutron guide segments
- (Remanent) polarizers
- Polarization analyzers
- Beam benders
- Band pass filters
- Focusing devices
- Focusing monochromators
- Multilayer monochromators
- Fiber lenses
- Toroidal mirrors
- Spin-flipper

=> NOTS has to be a time-of-flight instrument!

# Resolution requirements



**Example:**  
**Ni/Ti multilayer**  
**for R&D on supermirrors**

⇒ A resolution of

$$\frac{\Delta q}{q} \geq 0.02$$

seems to be appropriate  
for most applications.

# Requirements for NOTS instrument length and chopper set-up



$$\begin{aligned}\left(\frac{\Delta q}{q}\right)^2 &= \left(\frac{\Delta \vartheta}{\vartheta}\right)^2 + \left(\frac{\Delta \lambda}{\lambda}\right)^2 \\ &= \left(\frac{\Delta \vartheta}{\vartheta}\right)^2 + \left(\frac{\Delta L_{TOF}}{L_{TOF}}\right)^2 + \left(\frac{\Delta t_{TOF}}{t_{TOF}}\right)^2 \\ &= \left(\frac{\Delta \vartheta}{\vartheta}\right)^2 + \left(\frac{\Delta L_{TOF}}{L_{TOF}}\right)^2 + \left(\frac{\Delta t_{Chopper}}{t_{TOF}}\right)^2 + \left(\frac{\Delta t_{Detector}}{t_{TOF}}\right)^2 + \left(\frac{\Delta t_{Det.elec.}}{t_{TOF}}\right)^2\end{aligned}$$

$\Delta$ :

Standard deviation of the parameter

$\Delta \vartheta$ :

Angular divergence of the neutron beam

$\Delta L$ :

Uncertainty of travel distance due to different flight paths

$L_{TOF}$ :

Travel distance between chopper “window” and detector

$t_{TOF}$ :

Time-of-flight (TOF)

$\Delta t_{TOF}$ :

TOF uncertainty

$\Delta t_{Chopper}$ :

TOF uncertainty due to chopper pulse width

$\Delta t_{Detector}$ :

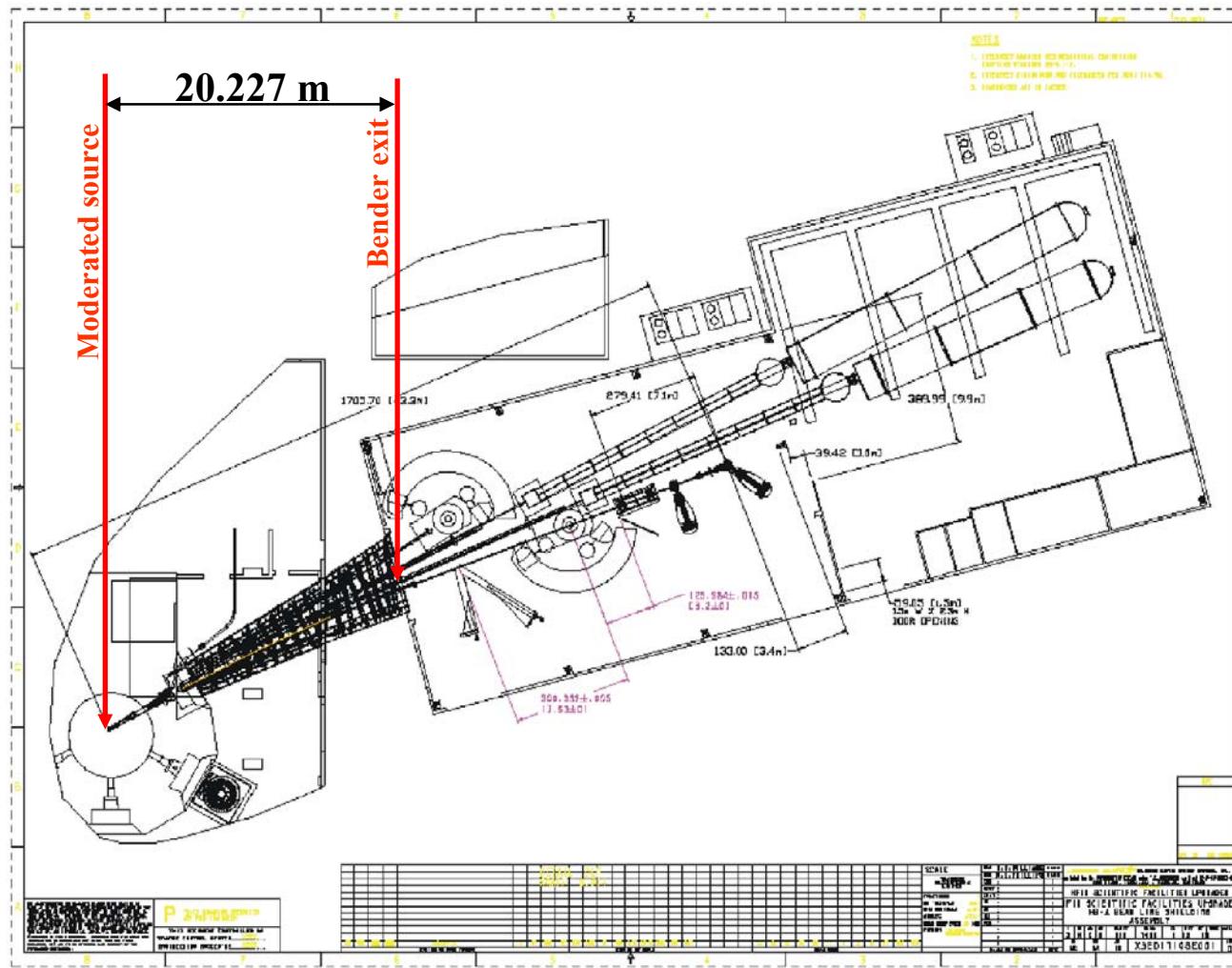
TOF uncertainty due to neutron detection process

$\Delta t_{Det.elec.}$ :

TOF uncertainty due of detector electronic

- ⇒ For 2% q-resolution, the total length of NOTS needs to be on the order of > 10 m.
- ⇒ A double-disk chopper system provides  $\Delta t/t_{TOF} = \text{constant}$ .

# HFIR floor plan



# HFIR beamline CG-4



## - Source

width: 0.0852 m; height: 0.0852 m

flux density:  $5.286 \cdot 10^{18}$  n/m<sup>2</sup>/s

--- Distance between source and collimator: a = 2.832 m ---

## - Collimator (length: 0.730 m)

entrance width: 0.0494 m; exit width: 0.0410 m

entrance height: 0.1076 m; exit height: 0.1100 m

--- Distance between collimator and shutter channel: b = 0.468 m ---

## - Shutter Channel (length: 0.641 m)

entrance width: 0.0356 m; exit width: 0.0282 m

entrance height: 0.1115 m; exit height: 0.1136 m

--- Distance between shutter channel and bender section I: c = 0.626 m ---

## - Bender Section I (length: 6 m)

entrance width: 0.019m; exit width: 0.019 m

entrance height: 0.1156 m; exit width: 0.150 m

4 channels with 0.0005 m thick dividers

36 elements, 0.16667 m long with 0.0889° adjacent angle

coating: m = 2.5

## - Bender Section II (length: 9 m)

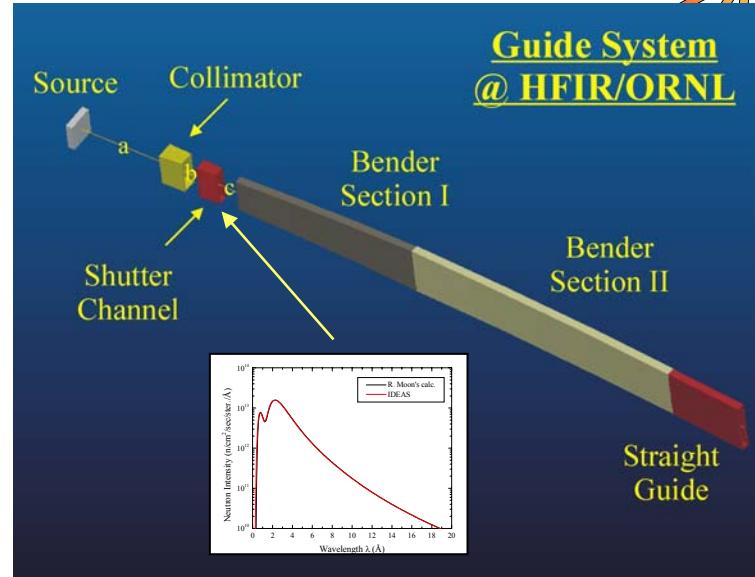
width: 0.019m

height: 0.150 m

4 channels with 0.0005 m thick dividers

54 elements, 0.16667 m long with 0.0889° adjacent angle

coating: m = 2.5



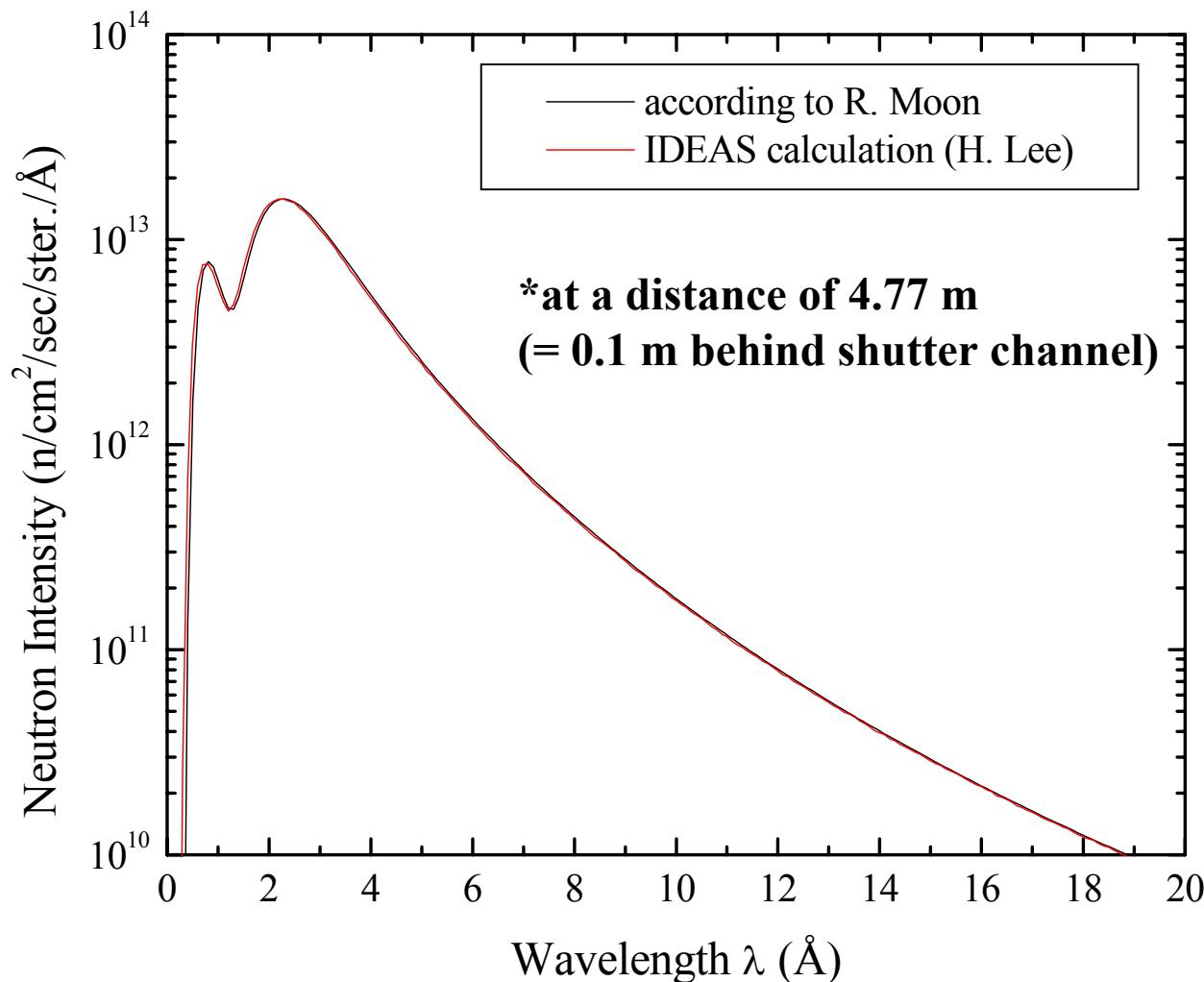
total deflection of bender sections I + II (i.e., over 15 m): 8°  $\leftrightarrow$  r = 107.43 m

## - Straight Guide (length: 2.5 m + 9.405 m = 11.905 m)

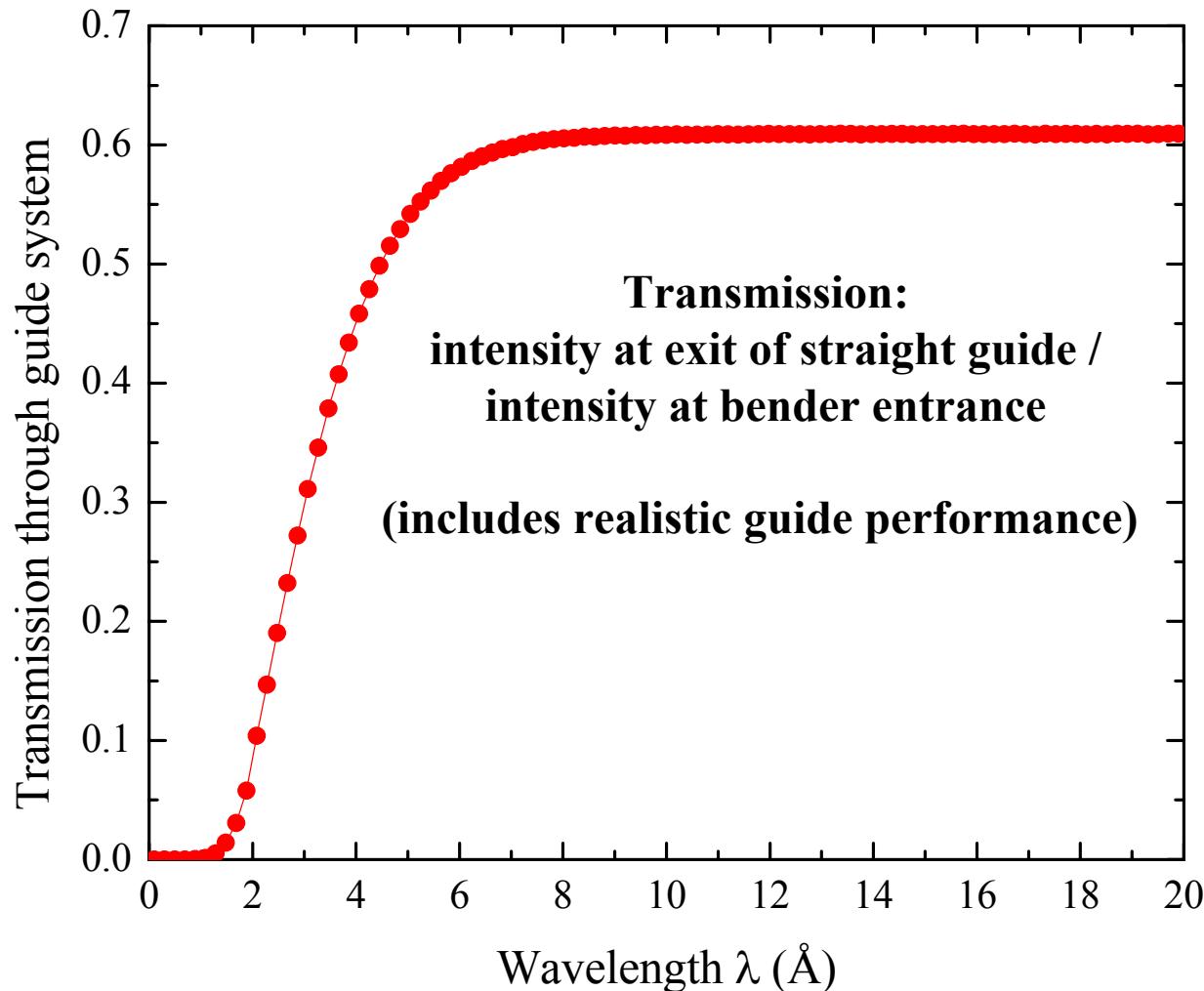
width: 0.019 m; height: 0.150 m

coating: m = 2

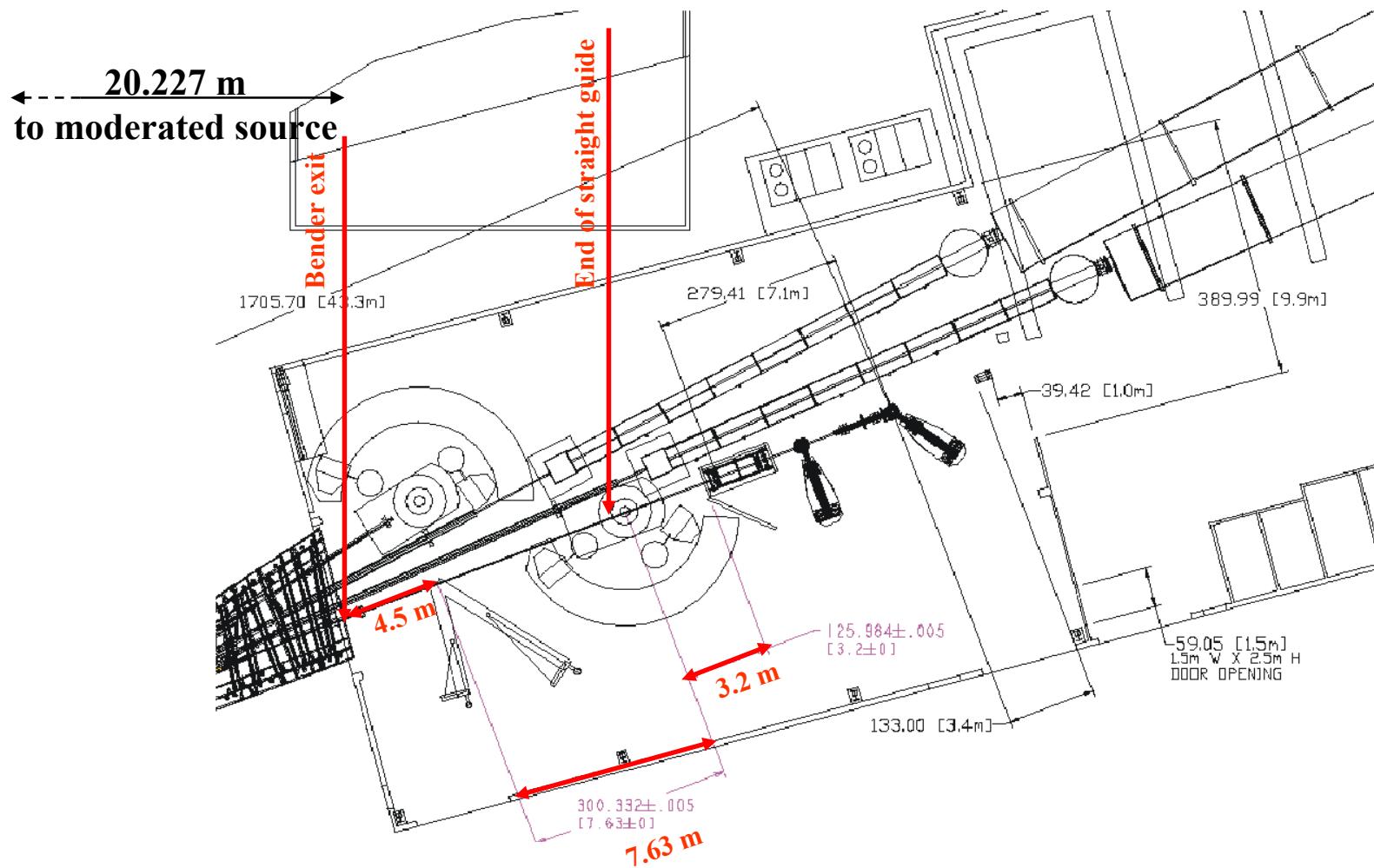
# HFIR source brightness\*



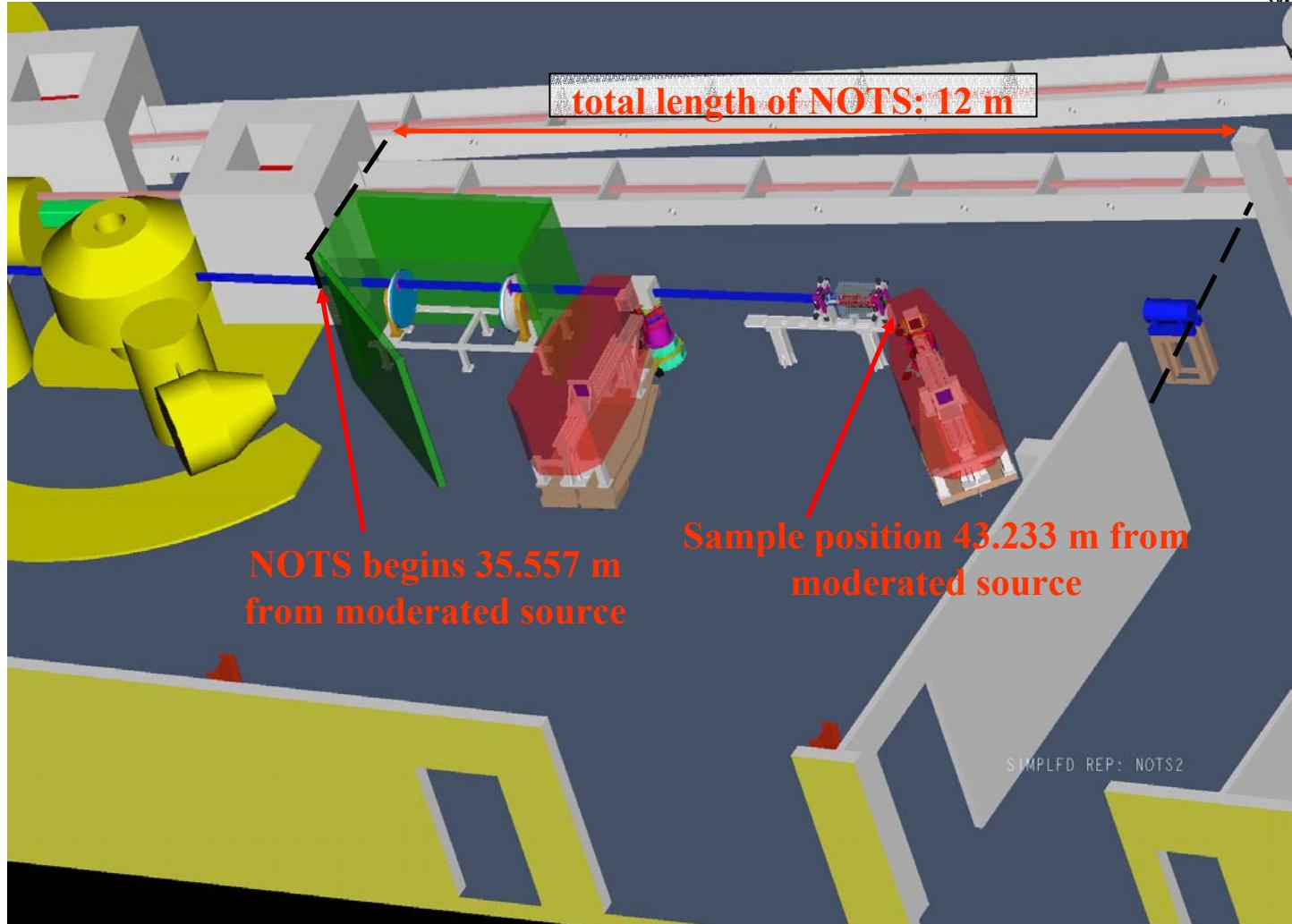
# Transmission through CG4 guide system



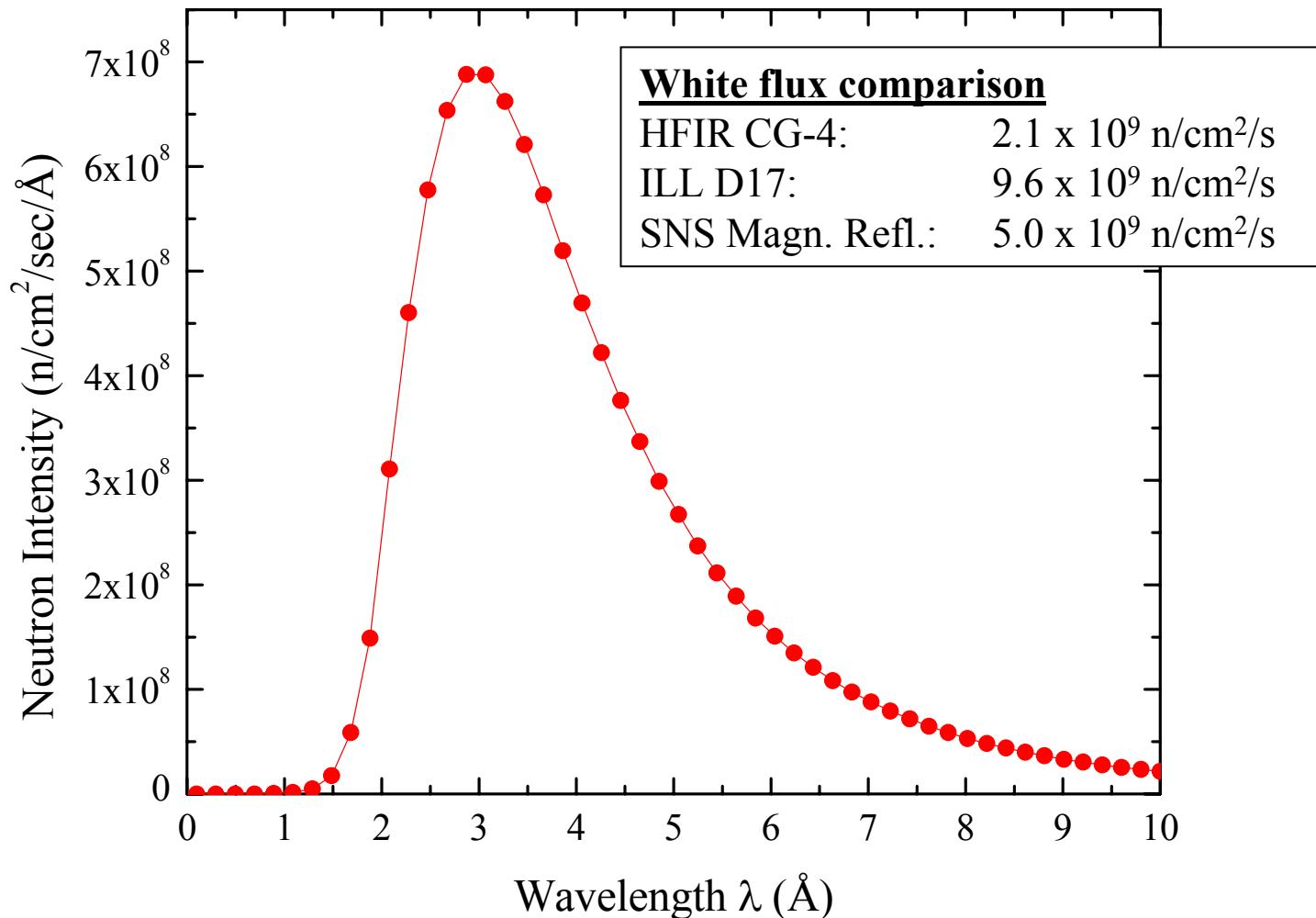
# HFIR guide hall



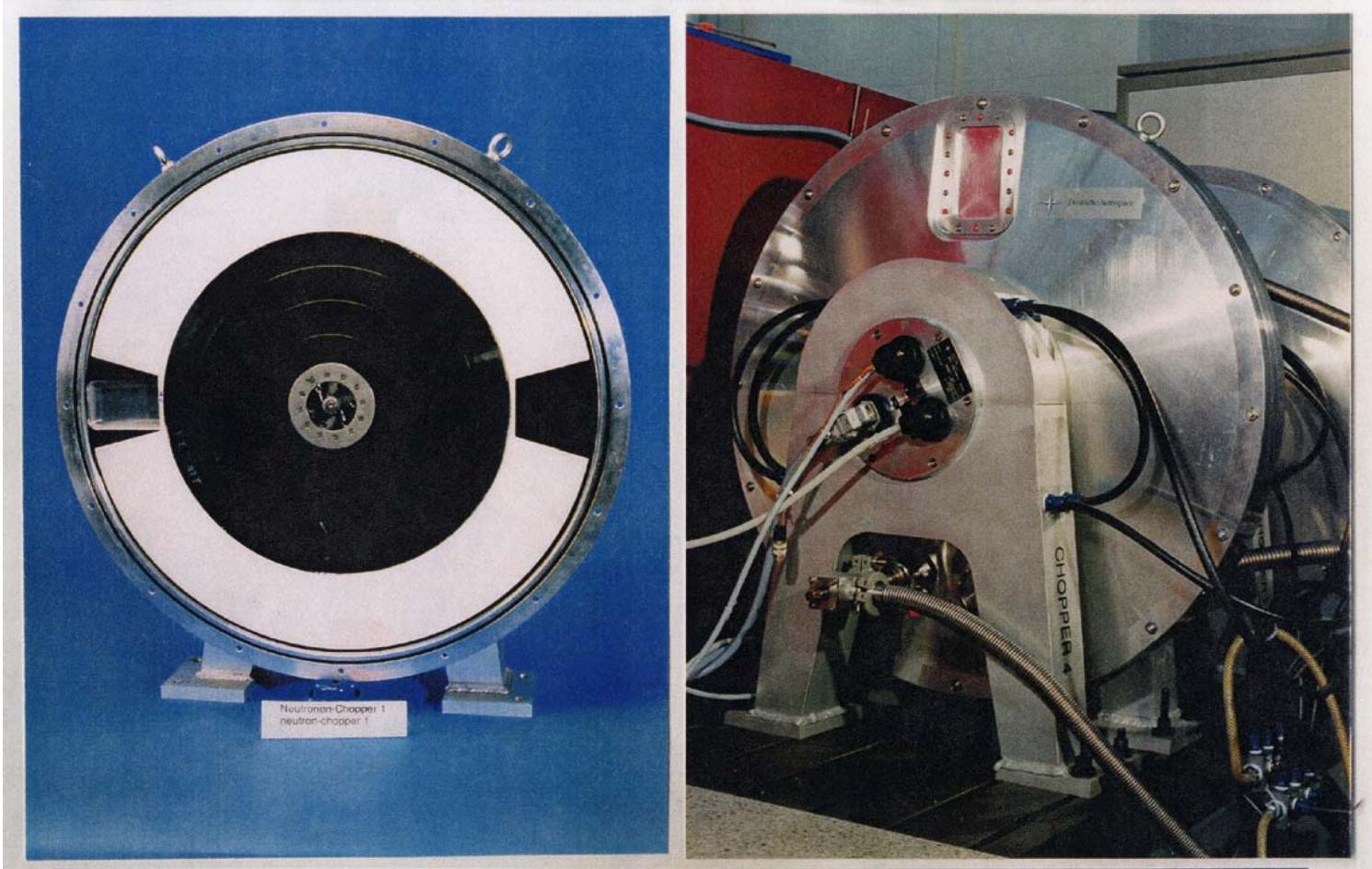
# NOTS at HFIR



# Spectrum of CG-4 at NOTS entrance

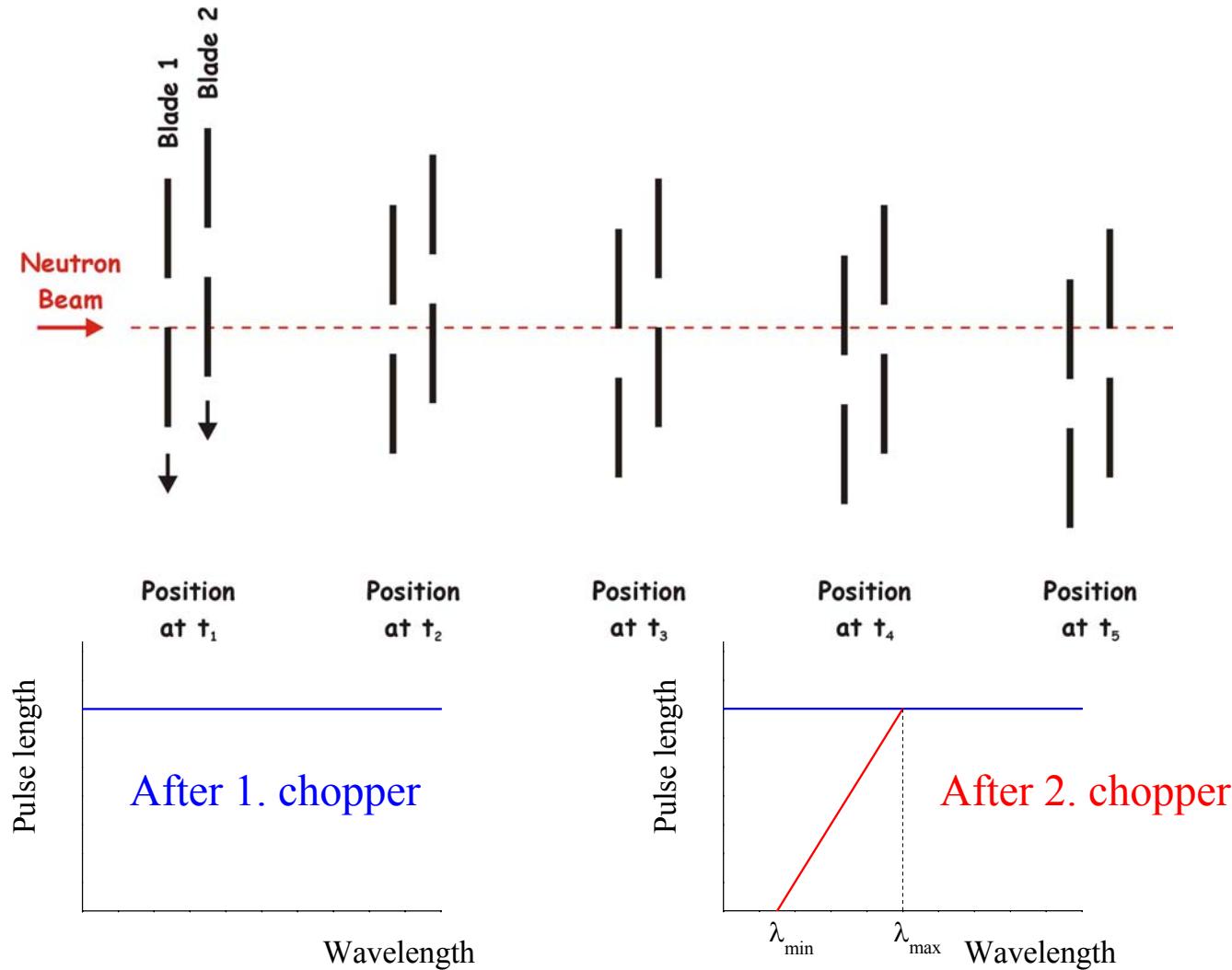


# Astrium 60 Hz disk choppers

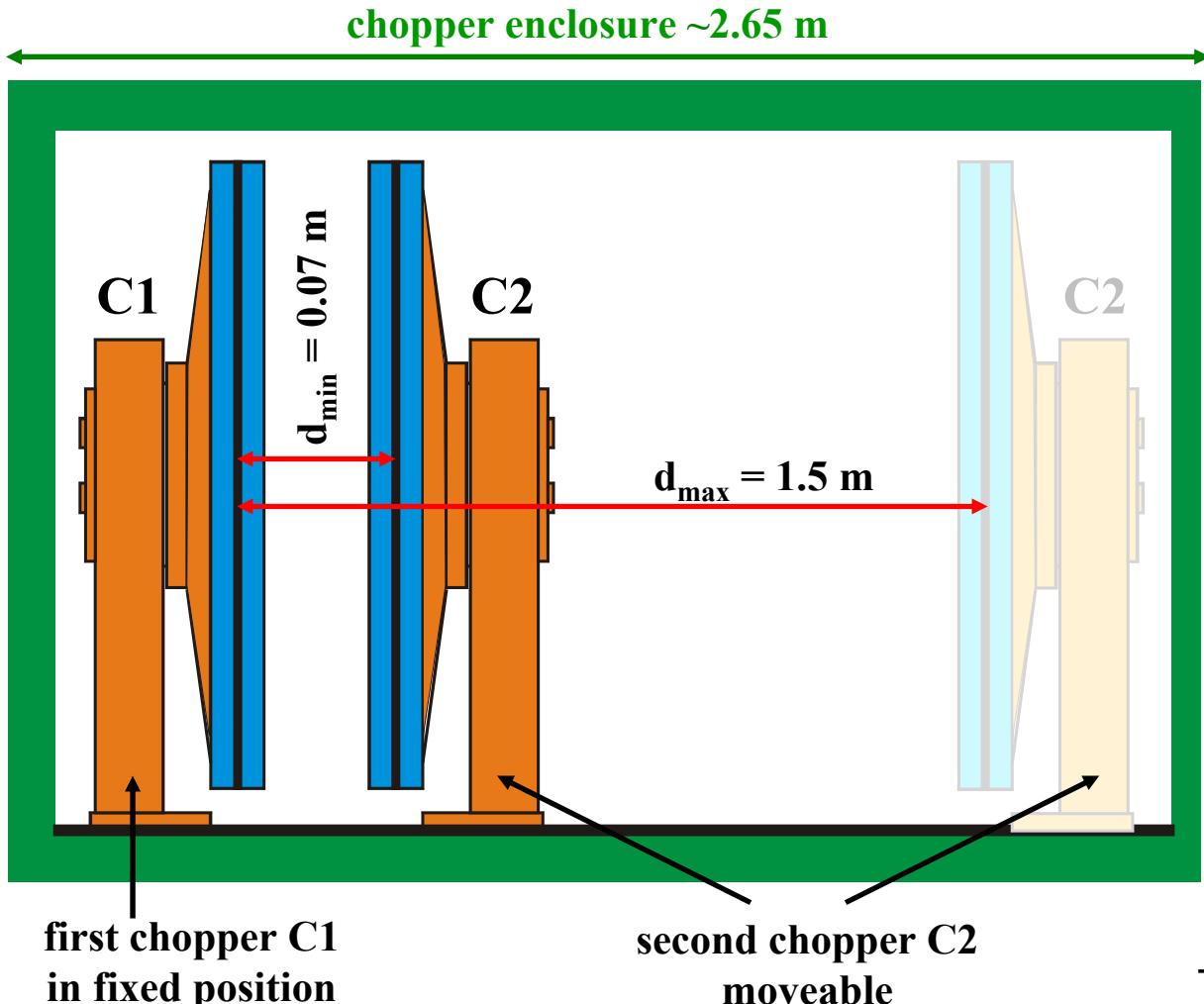


Procurement initiated: Fall 2001

# General principle of a double-disk chopper system



# The NOTS double-disk chopper system



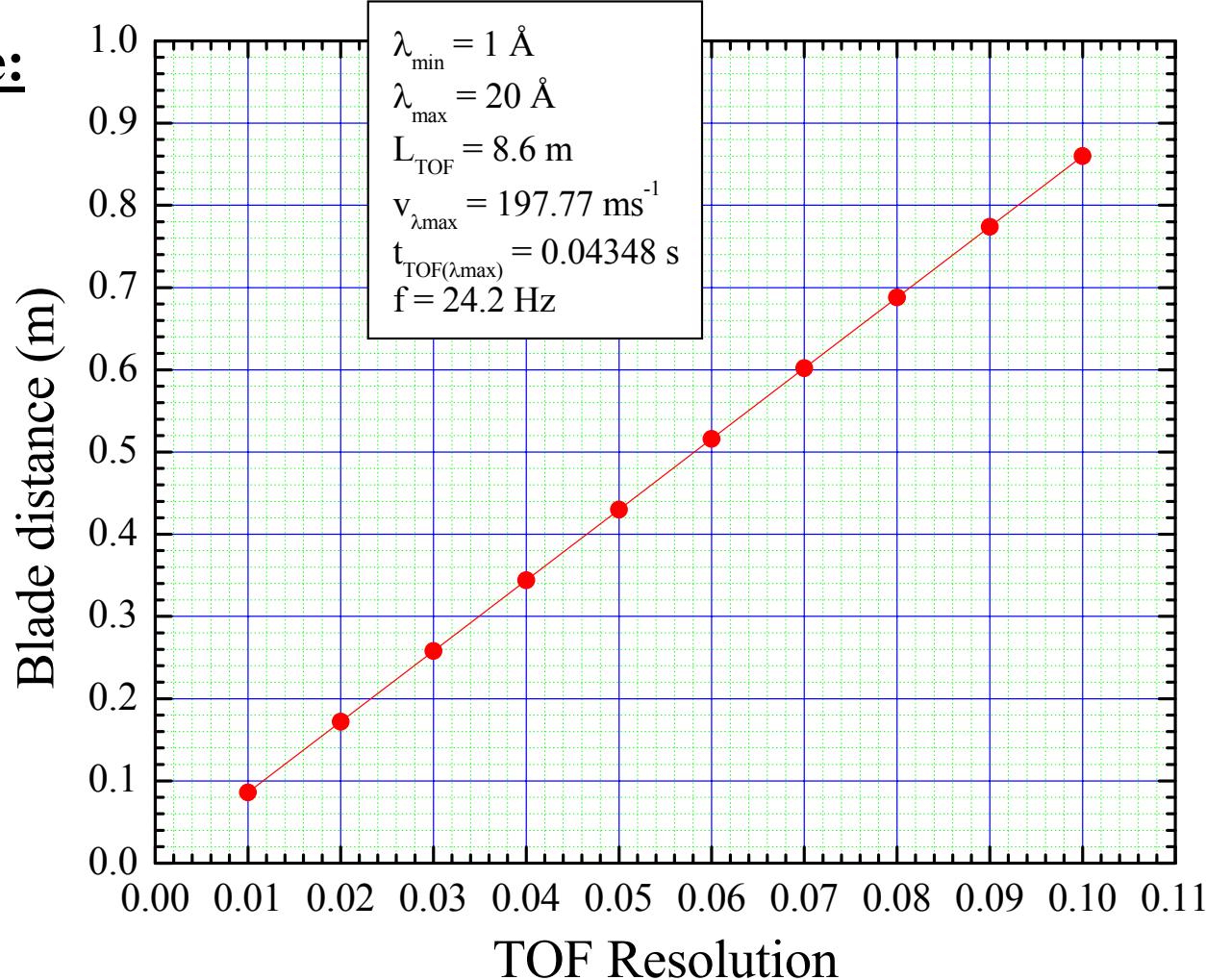
Variable chopper  
distance  
&  
variable chopper  
blade opening

allow  
  
Trading of  
Resolution vs. Intensity

# Chopper blade distance vs. TOF resolution



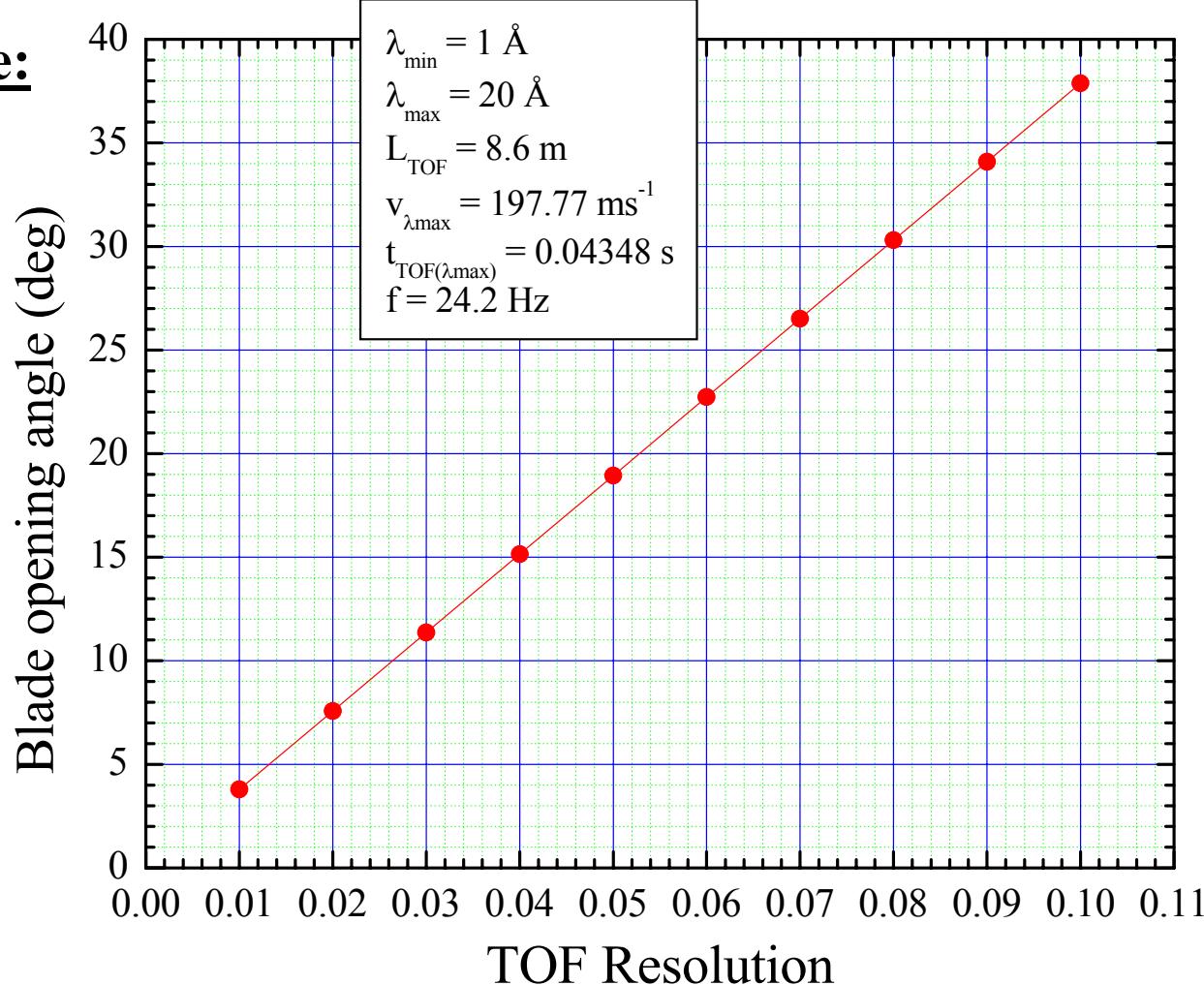
Example:



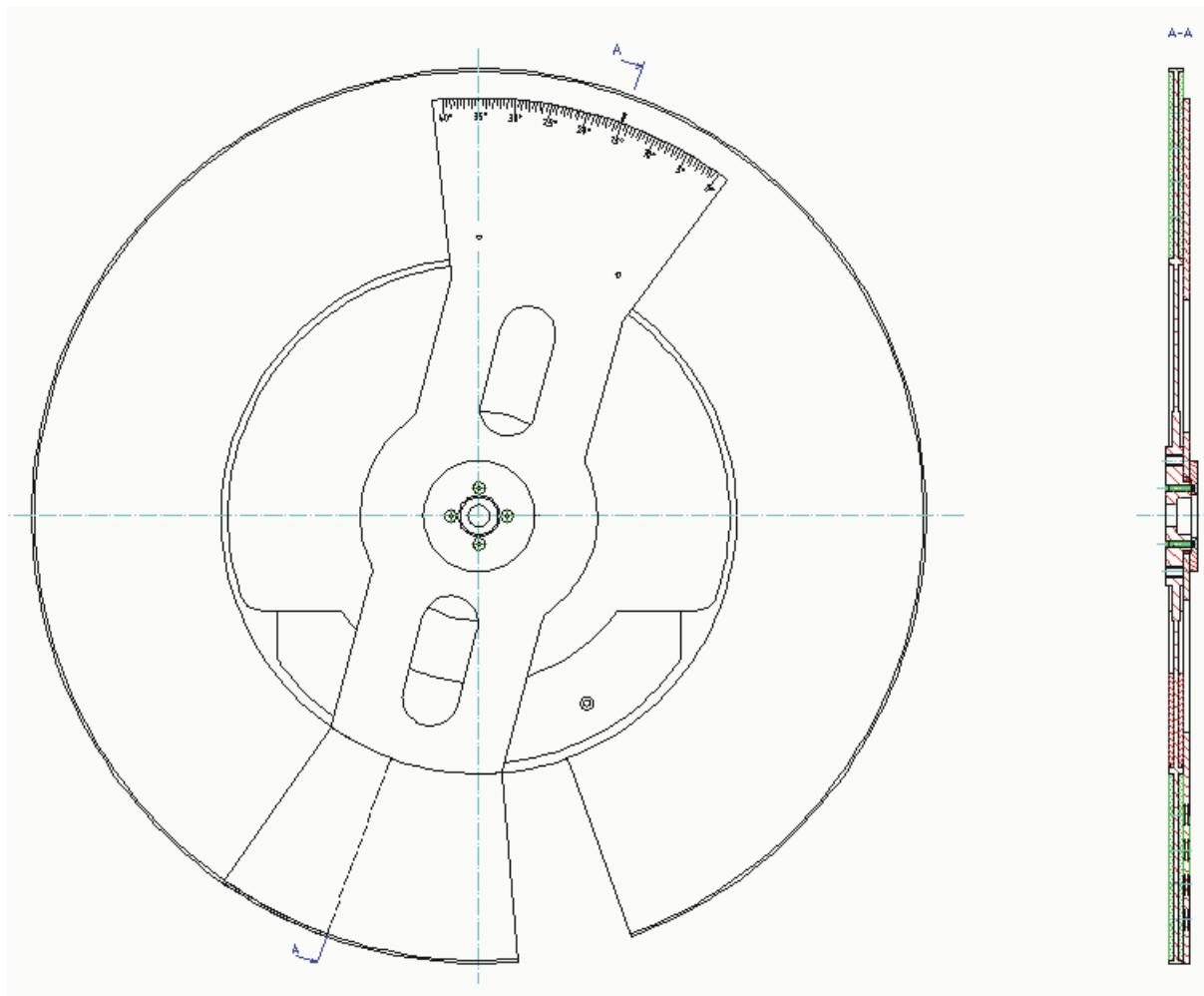
# Chopper blade opening angle vs. TOF resolution



Example:



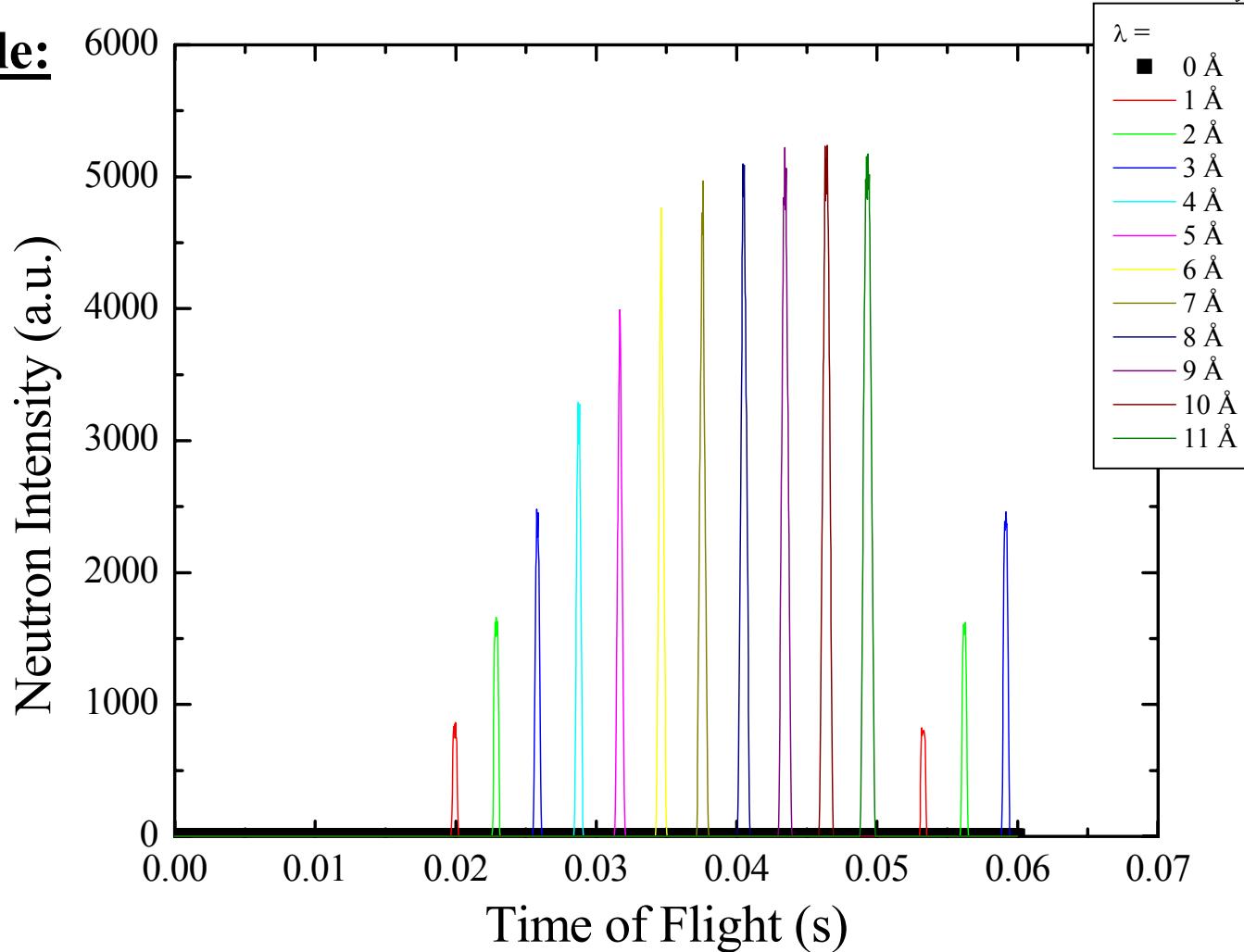
# Adjustable blade aperture



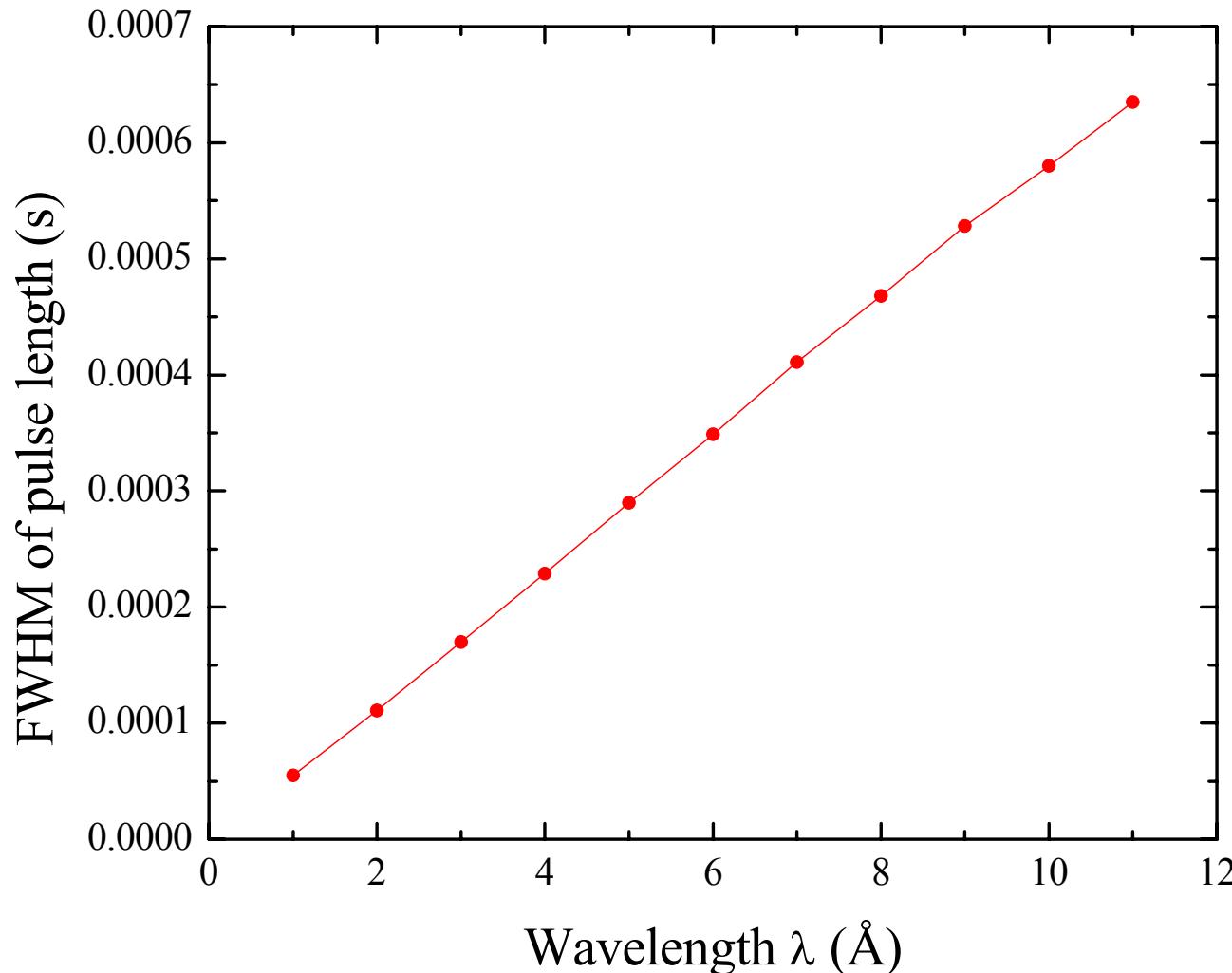
# Wavelength-dependence of pulse lengths at detector



Example:



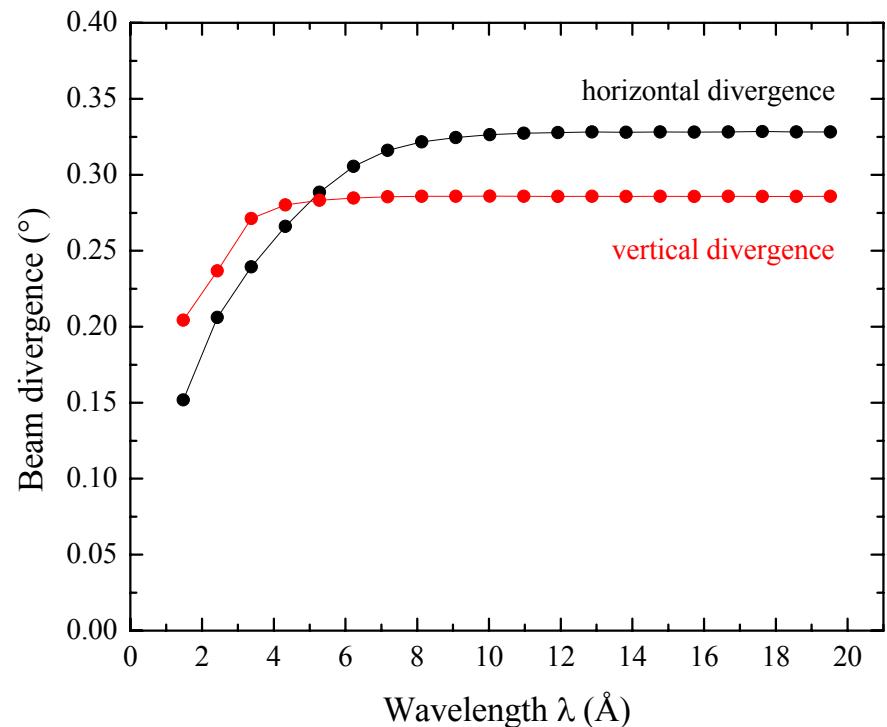
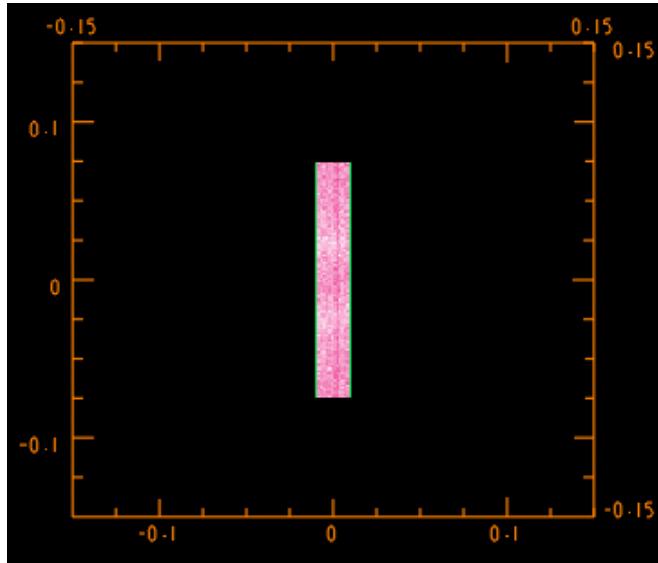
# Wavelength-dependence of pulse lengths at detector



# Beam divergences at end of straight guide\*



\* ~11.1 m before NOTS sample position



# Beam divergences at NOTS sample position\*



\* ~11.1 m after end of straight guide

